AN2229
APPLICATION NOTE

Startup Behavior L9903/L9904

Introduction

Purpose of the Application Note is to detail the startup behaviour of L9903 and L9904 devices and to explain a correct initialization sequence, possibly being necessary when application configuration is different from the one suggested inside datasheet.

In fact, in case an additional, external diagnostic structure is used, it may happen that after a first connection of the supply voltage, and before first enabling of the device, the measurement results of these diagnostic structure is not precise.

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1 Explanation of 2 possible Startup Behaviors

Starting condition: the device is disconnected from the battery.

After switching on V_S, as long as the voltage over C_{Boot} is below 3.5V, the device can have 2 startup states:

a) Gate of high side driver is internally switched to ground (Fig. 1).

b) Gate of high side driver is internally switched to CBx (Fig. 2).

If the voltage (C_{Boot}) exceeds 3.5V the device switches always like shown in figure 1

Figure 1. Startup behavior internal switched to ground (state 1)

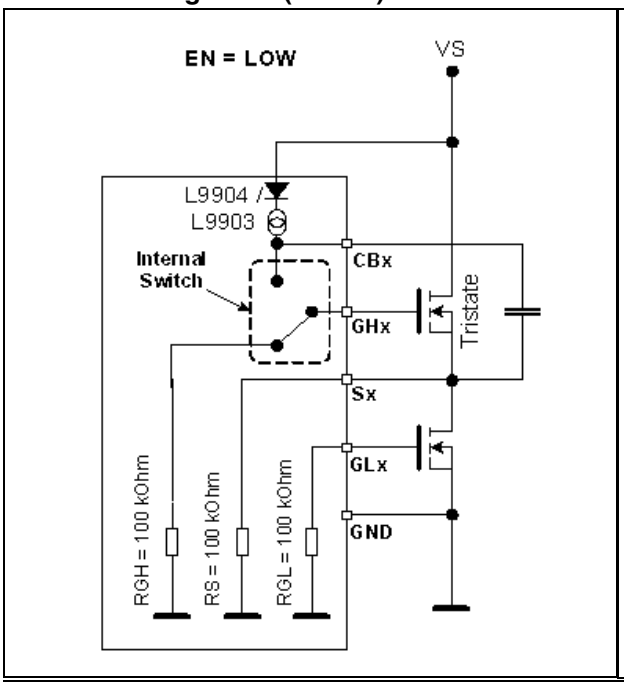
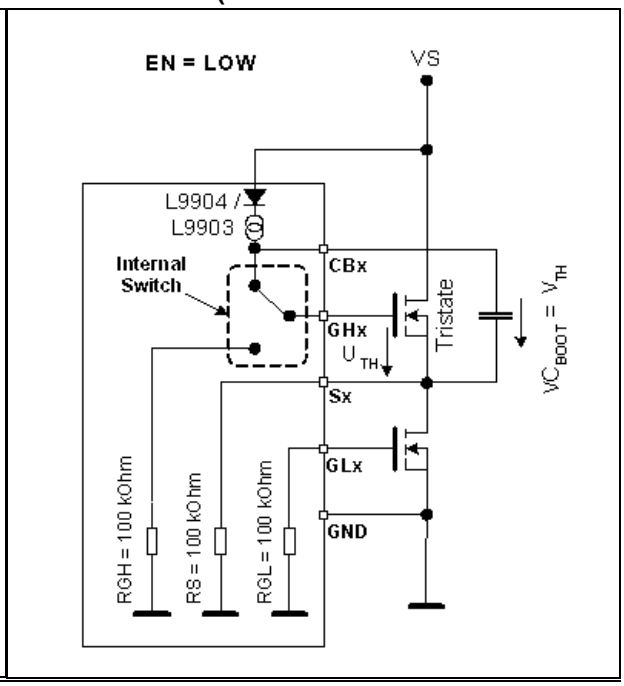


Figure 2. Startup behavior internal switch to CBx (state 2.

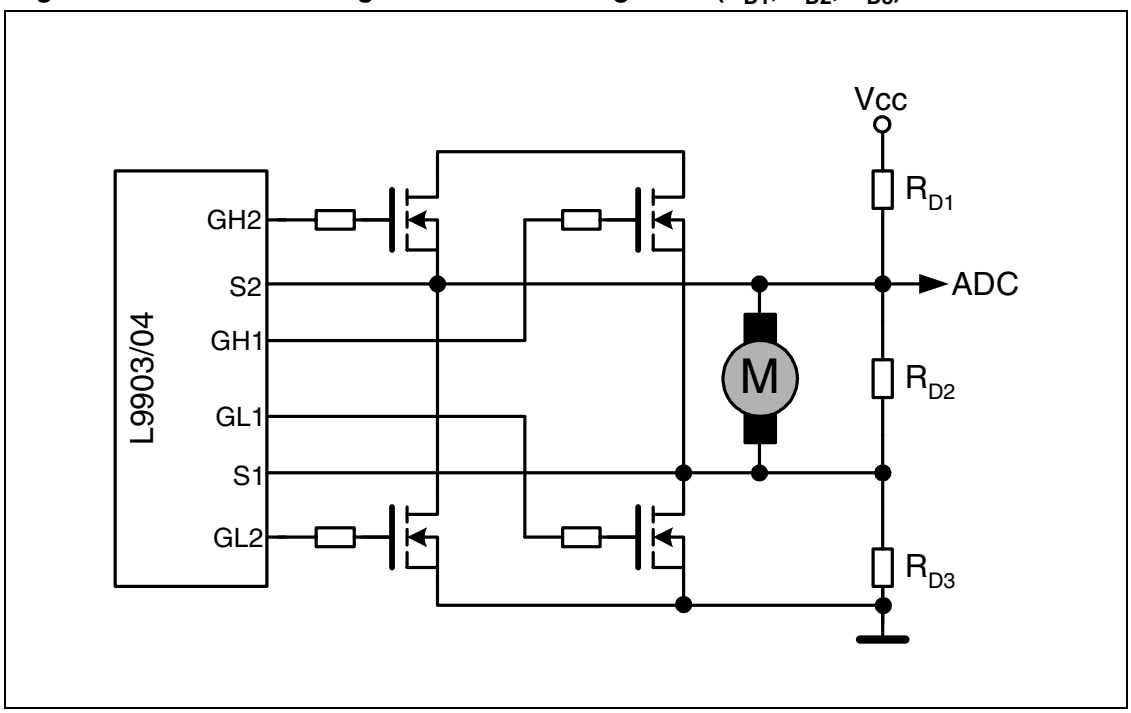


After the first VS ramp up the outputs will enter one of the explained states.

If the device enters state 2 and the threshold of the external MOSFET is below 3.5V, the Sx pin will raise and the charging of the bootstrap capacitor will be stopped. This state will persist until the L9903/04 will be enabled by the EN pin. The only consequence of entering state 2 is an increased leakage current. There is no influence on the standard application suggested inside datasheet. There is no influence on operating condition (EN=HIGH). If the application requires a startup behavior like in figure 1, an initialization is needed (see sections *3* and *4*).

2 Application example using standby voltage monitoring

Figure 3. DC motor driving with additional diagnostic (R_{D1}, R_{D2}, R_{D3})



Some applications may use external circuitry, for instance for advanced diagnosis in standby mode. In figure 3 for example, an additional external resistive network is implemented, to measure a potential short circuit or open load condition.

A short circuit or an open load condition can be detected by the ADC of a microcontroller, by monitoring voltage levels of the resistive network.

If L9903/04 is not initialized correctly upon first V_S ramp up, the described state 2 could be entered. The voltage levels of the external circuitry could be influenced, eventually leading to a temporary wrong diagnosis.

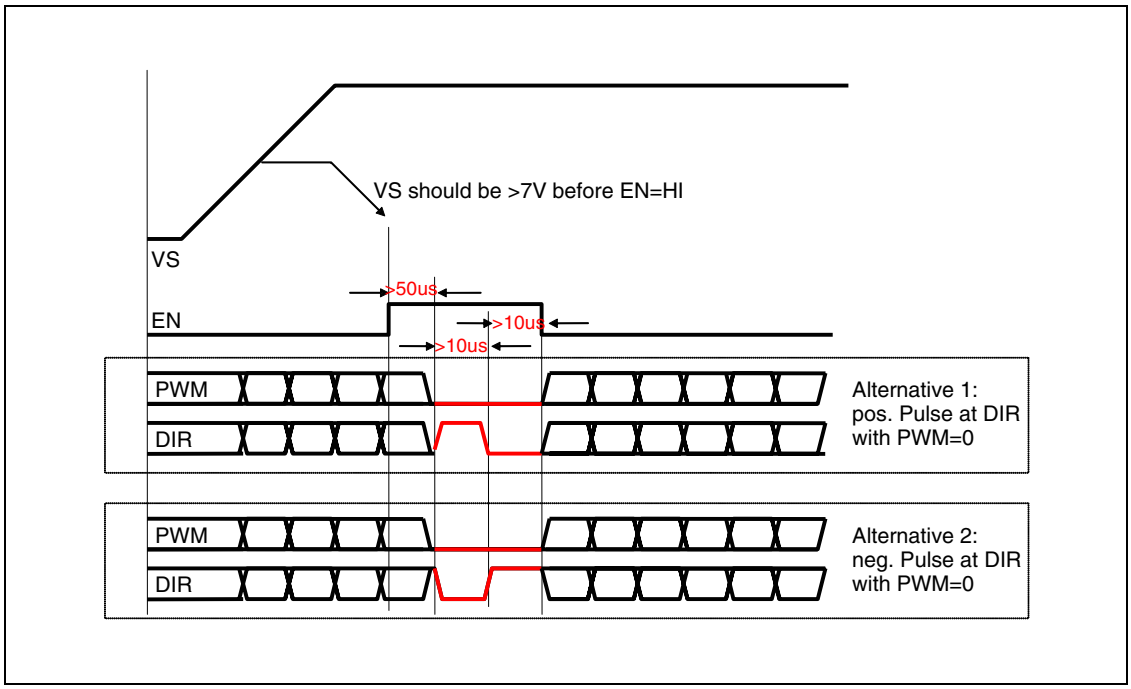
Hence it is mandatory to initialize the device if the application requires monitoring of voltage levels in standby mode (EN=LOW) after the first V_S ramp up. Normal operation (EN=HIGH) is not influenced. Later standby modes are also not influenced.

Once the device is initialized properly, the resistive output versus ground is always present (figure 1) in standby mode.

3 Proposed initialization sequences for L9903:

Alternative 1:	Vs > 7V	
	EN = High	for >50µs
	PWM = Low	after 50µs of EN
	DIR = High	for >10µs after min 50µs of EN
	DIR = Low	for >10µs after min 10µs DIR = High after min 50µs of EN
Alternative 2:	Vs > 7V EN = High	after 50µs of EN
	PWM = Low	positive Edge after min 50µs of EN
	DIR = Low	for >10µs after min 50µs of EN
	DIR = High	for >10µs after min 10µs DIR = Low after min 50µs of EN

Figure 4. Proposed Sequence to Initialize L9903 after V_S is applied

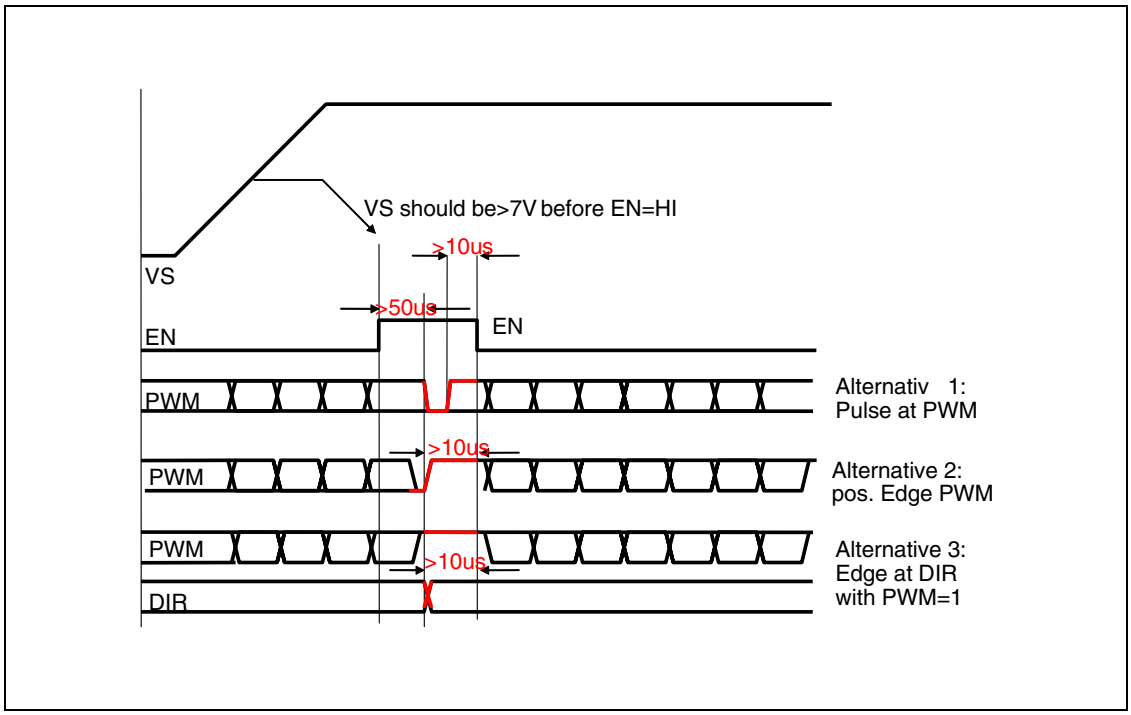


Two possible solutions. Important is that after enabling the L9903 both LS transistors willb be switched-on (Sx forced o GND) for at least 10µs (C_{boot}=100nF) to allow boostrap capacitor to be charged. This is realized by changing the DIR-input while PWM is low. The min 50µs delay are needed for the internal circuit to setup. A signal change within the 50µs may not be detected.

4 Proposed initialization sequences L9904:

Alternative 1:	Vs > 7V	
	EN = High	for >50µs
	PWM = Low Pulse	after 50µs of EN
	PWM = 1	for >10µs
Alternative 2:	Vs > 7V	
	EN = High	for >50µs
	PWM = Edge	positive Edge after min 50µs of EN
	PWM = 1	for >10µs
Alternative 3:	Vs > 7V	
	EN = High	for >50µs
	PWM = 1	for >10µs after Edge of DIR 50µs of EN
	DIR=Edge	after 50µs of EN

Figure 5. Proposed Sequence to Initialize L9904 after V_S is applied



Three possible solutions. Important is that PWM=1 will be detected after enabling the L9904 to switch on both LS transistors (break mode). Therefore an edge at PWM or DIR input has to be present 50µs (or more) after EN was set HI. The 50µs delay are needed for the internal circuit to setup. A signal change within the 50µs may not be detected. After this edge the PWM should be HI for at least 10µs (C_{Boot}= 100nF) to charge the CBx bootsstrap capacitors (depending on value of capacitor)

5 Revision history

Date	Revision	Changes
October 2005	1	Initial release.

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